Message

From: g.d.beckett@aquiver.com [g.d.beckett@aquiver.com]
Sent: 10/7/2021 9:58:35 PM
To: Grange, Gabrielle Fenix [gabrielle.grange@doh.hawaii.gov]; Palazzolo, Nicole [Palazzolo.Nicole@epa.gov]
Subject: RE: Red Hill LNAPL Model Example

Hi Fenix & Nicole,

Let me talk to Matt about that. I think we could toy around with his 3-D geologic model to create something that gets the message across, even though it's not an LNAPL model per se. One of the many challenges in appropriately modeling fuel-specific CF&T is that the multiphase models take a lot longer to setup and run than does even a large MODFLOW g.w. model. I don't recall the exact execution time of the Navy's models, but it was something around 10 minutes or so. I've run LNAPL models that can take many days to complete a single model run, just because the inter-related equations are non-linear and are much harder to solve numerically. For example, the hydraulic conductivity, which is a constant in g.w. models for each lithology, is a variable in NAPL models hinged to capillary pressures, saturations, intrinsic permeability, relative permeability and fluid properties with respect to each phase couplet (oil/water, water/air, oil/air) in each lithologic unit. But, despite the twists and turns, these types of models describe the facet of keen interest for Red Hill; how will fuel releases migrate, how rapidly, and would any reasonable release scenario create potential or likely risks to the aquifer and its designated uses?

But, I do think there are some hybrid approaches that are much simpler with respect to getting that message across about the 3-D complexity and how fast-track migration pathways might work.

Best regards

From: Grange, Gabrielle Fenix <Gabrielle.Grange@doh.hawaii.gov>
Sent: Thursday, October 7, 2021 3:15 PM
To: Palazzolo, Nicole <Palazzolo.Nicole@epa.gov>; g.d.beckett@aquiver.com
Subject: RE: Red Hill LNAPL Model Example

Great! Thanks, GD.

We may want to consider a 3D version to give a bit of a better sense of the variety of fast track pathways that could occur under different release locations and spill scales. Showing stakeholders the speed and mobility of LNAPL in the system may help get the message home in a way that just talking about CF&T hasn't been able to.

Fenix

From: Palazzolo, Nicole <Palazzolo.Nicole@epa.gov>
Sent: Thursday, October 7, 2021 10:24 AM
To: g.d.beckett@aquiver.com
Cc: Grange, Gabrielle Fenix <Gabrielle.Grange@doh.hawaii.gov>
Subject: [EXTERNAL] RE: Red Hill LNAPL Model Example

Great idea Gary. I will forward to Alex and Tom.

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From: g.d.beckett@aquiver.com <g.d.beckett@aquiver.com>
Sent: Thursday, October 7, 2021 9:42 AM
To: Palazzolo, Nicole <Palazzolo.Nicole@epa.gov>
Cc: Grange, Gabrielle Fenix <gabrielle.grange@doh.hawaii.gov>
Subject: RE: Red Hill LNAPL Model Example

Hi Nicole,

Would you like me to forward this modeling animation and note to Alex & Tom? Perhaps you already did so.

I think it was Tom who spoke about challenges in hard-rock basalt modeling of contaminant behavior, so it may be relevant. Again, it is a framing analysis only, we expect the actual conditions to be much more complex. That is often handled by geometric evaluations, scaling factors, or other approaches that can better capture the root causes of complex multiphase migration behavior. Our framing (Matt, Bob & I worked on this), however, is more complex & realistic than anything the Navy has so far done. Oversimplification often leads to non-conservative results.

The one key takeaway that I think was echoed on yesterday's call is that NAPL movement will always be highly complex in these types of settings. To me, the value of modeling is that it forces one to address the key elements of the processes at work and helps to narrow down which are important and which are not, as well as identifying specific uncertainties. A saying comes to mind: modeling may not tell you what is right, but it often tells you what is wrong.

Best regards

From: g.d.beckett@aquiver.com <g.d.beckett@aquiver.com>
Sent: Tuesday, September 28, 2021 5:34 PM
To: 'Palazzolo, Nicole' <Palazzolo.Nicole@epa.gov>; 'Carvalho, Gabriela' <Carvalho.gabriela@epa.gov>; 'Duffy, Mark' <duffy.mark@epa.gov>; 'Tu, Lyndsey' <Tu.Lyndsey@epa.gov>; 'Matt Tonkin' <matt@sspa.com>; 'Whittier, Robert' <Robert.Whittier@doh.hawaii.gov>; 'Shende, Anay' <anay.shende@doh.hawaii.gov>; 'dthomas@soest.hawaii.edu' <dthomas@soest.hawaii.edu>; 'g.d.becket aquiver.com' <g.d.becket@aquiver.com>; 'Ichinotsubo, Lene K' <lene.ichinotsubo@doh.hawaii.gov>; 'Grange, Gabrielle Fenix' <gabrielle.grange@doh.hawaii.gov>
Cc: 'Fong, Alison' <fong.alison@epa.gov>
Subject: Red Hill LNAPL Model Example

Hi folks,

It strikes me that with some new EPA folks, I may have jumped to some observations regarding the limitations of groundwater modeling alone to inform our considerations for the best applicable aquifer protection strategies. Fenix agreed it might be good to share our example draft fuel release modeling with you all before our call on Friday. The primary purpose of these multiphase modeling examples was to show our stakeholders and the Navy's technical team that such modeling can be efficiently done to address the flaws of the Navy holding model and their other proposed approaches. Those primary flaws are: a) non-dynamic; b) uniformity of modeling dimensions, unconstrained by any field data; c) residual already in-place; d) cannot simulate time-dependent migration; and e) all parameters are assumed from inapplicable literature (no acceptable site or area-specific measurements).

As background, Matt and I worked on the lithologic distributions based on the 3-D geologic model available at that time. We then took a lithologic "slice" through the axis of the Tank Farm to feed into a 2-D numerical model in cross-sectional orientation. That model, MAGNAS3 (1998), is fully capable of 3-phase simulation (vapor, NAPL and water) in 1-, 2-, and 3-D. We chose 2-D for our draft example to keep the work effort minimal. We were not recommending that model per

se, although Sorab Panday is certainly proficient with it as he is one of its co-authors. But we did intend to point out the importance of heterogeneity, release characteristics, and anticipated changes with time and distance. Our example models were then parameterized with known and assumed parameters for the lithologies and fuel, along with 3 release scenarios (small, large & chronic). The releases were scaled downward in volume to account for the way 2-D models account for mass; i.e., a more realistic but less conservative assumption. The model input parameters were based on site values were available (e.g., aquifer testing for hydraulic conductivity), or literature and compiled data. Some of you know that I compiled the API LNAPL Parameters DB (API #4731) and these attributes were part of my research focus at SDSU. Because of our demonstration of the inapplicability of the Navy's petrophysical testing results, assumed properties are all that are available to any of us for most of the sensitive factors (e.g., relative permeability, capillarity, etc.).

Anyway, this type of modeling can inform us about the rate, distances, and degree of aquifer impacts that might occur under various release conditions. Further, we have presented some literature on the often fractal and heterogeneous behavior of NAPLs in hard-rock settings. That kind of architectural framing would also be relevant to the upscaling of various parameters, such as residual capacity. We have asked for that from the Navy many times, but nothing returned thus far. Absent realistic and conservative modeling, we would be left to assume potential conditions, which can also be done (but has not by Navy).

Ultimately, it will be the nexus between fuel transport and the potential methods of its mitigation that will determine the best aquifer protection measures. If for instance, a large-scale release is estimated to generate LNAPL gradients that exceed transient groundwater capture gradients, then capture will fail to appreciably mitigate aquifer damages. That is why, again even with a perfect groundwater model, the Navy cannot at this stage determine what release mitigation measure might actually work under applied conditions. Half the question, and arguably the more complex half, remains unaddressed (LNAPL migration at local scale). The other half (the GWFMs) are steady-state (not applicable to transient questions) and do not adequately reflect area data & conditions (they are faulty besides). So even though our meetings are ostensibly about the GWFMs, these broader issues are important to achieving groundwater protection measure in which we can have confidence and communicate that to our stakeholders.

Best regards, let me know if I have left any key questions unexplained in the above.